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(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Low Shrink Force Shrink Film Containing Homogeneous
Substantially Linear Polymer Having Long Chain Branching

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LOW SHRINK FORCE SHRINK FILM CONTAINING HOMOGENEOUS SUBSTANTIALLY LINEAR POLYMER HAVING LONG CHAIN BRANCHING

FIELD OF THE INVENTION

The present invention relates generally to films, both monolayer films and multilayer films, and particularly to packaging films. The present invention also relates to packages, especially packages having one or more seals, as well as packaged products. The present invention is particularly related to film having a relatively low shrink force, i.e., so-called "low shrink tension films."

BACKGROUND OF THE INVENTION

In the past, heat shrinkable films exhibiting low shrink tension, i.e., "soft-shrink films," have been produced using polyvinyl chloride ("PVC"), very low density polyethylene ("VLDPE"), ethylene/vinyl acetate copolymer ("EVA"), ethylene/butyl acrylate copolymer ("EBA"), and various blends of these polymers. These polymers are generally used in one or more inner layers of a multilayer film, with one or more higher melting polymers in the outer layers of the film. The inner layer or layers make up the majority of the thickness of the film.

In this manner, a soft-shrink multilayer film can be manufactured by orienting a tape at a temperature: (a) higher than the melting point of the polymer making up the inner layer(s), while being (b) below the melting point of the polymer making up the outer layers of the film. In this manner, the resulting oriented film has stress present primarily in the outer layers, as the polymer in the inner layer(s) is relatively stress-free because the polymer chains remains relaxed throughout orientation. Since the inner layer(s) preferably make up the majority of the thickness

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of the film, the relatively thin outer layers are able to impart only a small amount of shrink tension upon subsequent shrinkage of the film. Low shrink tension provides advantages in the packaging of, for example, paper products and textile products. Many such products can be easily distorted, i.e., are distortable upon the shrinkage of a film having a shrink tension of at least 350 psi. For aesthetic reasons and other reasons, it is much preferred to package such products without distortion, i.e., without bending of the product.

In general, polyethylene homopolymer, high density polyethylene ("HDPE"), linear low density polyethylene ("LLDPE"), and most other polyethylenes are not well suited for use as the inner layers of a multilayer shrink film which exhibits low shrink tension, because such polymers have too high a melting point, thereby necessitating the use of still higher melting point polymers as the outer layers, together with the use of undesirably high orientation temperatures in the manufacture of such a soft-shrink film. However, because of the many advantages associated with polyethylene polymers, such as price, ready availability, ease of processing, suitablility for use in packaging of food, recycleability, compatibility with other polymers, etc., it would be desirable to provide a soft shrink film having inner layers predominantly composed of polyethylene.

A new type of polyolefin, broadly referred to as homogeneous polymers, particularly homogeneous ethylene/alpha-olefin copolymers, have been marketed within the past few years. Homogeneous polymers are recognized as providing advantages in several areas, including strength, toughness, processability, optics, hot tack, heat seal initiation temperature, and even low shrink force.

SUMMARY OF THE INVENTION

It has been discovered that a novel class of homogeneous polymers, known as "substantially linear olefin polymers", which have long chain branching, can be used to provide an unexpectedly low shrink force for use in soft-shrink films. Such polymers and methods of

preparation thereof are disclosed in U.S. Patent No. 5,272,236, to Lai, et. al., and U.S. Patent No. 5,278,272, to Lai, et. al., both of which are hereby incorporated by reference thereto, in their respective entireties. It has been discovered that the polymers of Lai et al., i.e., homogeneous substantially linear olefin copolymers having long chain branching, can be used to provide a film exhibiting low shrink tension relative to other homogeneous ethylene/alpha-olefin copolymers.

As a first aspect, the present invention pertains to a shrink film comprising a first thermoplastic polymeric component and a second thermoplastic polymeric component. The first thermoplasic polymeric component comprises homogeneous substantially linear ethylene/alpha-olefin copolymer having a density of less than about 0.92g/cc, preferably from about 0.87 to 0.92 g/cc. The second thermoplastic polymeric component has a melting point at least 10°C higher than a melting point of the first component. The shrink film has an average shrink tension at 220°F of less than about 300 psi.

Preferably, the film has an average free shrink at 220°F of at least about 15 percent; more preferably, the shrink film has an average free shrink at 220°F of from about 15 to 80 percent; still more preferably 20 to 65 percent, and yet still more preferably, from about 20 to 65 percent. Preferably, the shrink film has an average shrink tension at 220°F of from about 100 to 300 psi; more preferably, from about 170 to 300 psi; and still more preferably, from about 240 to 300 psi.

Preferably, the first component further comprises at least one member selected from the group consisting of ethylene/vinyl acetate copolymer, very low density polyethylene, ethylene/butyl acrylate copolymer, and ethylene/methyl acrylate copolymer, i.e., present in combination with the homogeneous substantially linear ethylene/alpha-olefin copolymer. Preferably, the second component comprises at least one member selected from the group consisting of ethylene/alpha-olefin copolymer, polyethylene homopolymer, ethylene/vinyl acetate copolymer, polyester, and polypropylene. Propylene/ethylene copolymer is a particularly preferred polypropylene.

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Preferably, the film is a three- layer film comprising two outer layers each comprising the second thermoplastic polymeric component, and a single inner layer comprising the first thermoplastic polymeric component. Preferably, the first thermoplastic polymeric component comprises a blend of about 82 weight percent of an ethylene/octene copolymer having a density of about 0.92 g/cc and a melt index of about 1 g/10min, and about 17 weight percent of an ethylene/octene copolymer having a density of about 0.92 and a melt index of about 6 g/10min.

The present soft-shrink film can be either a monolayer film or a multilayer film. If it is a monolayer film, it preferably comprises a substantially uniform blend of the first component and the second component.

If the shrink film is a multilayer film, it preferably comprises at least one inner layer comprising the first component, and at least one outer layer comprising the second component. More preferably, the multilayer film comprises two outer layers, both of the outer layers comprising the second component, and at least one inner layer comprising the first component.

Preferably, at least one member selected from the group consisting of the first component and the second component comprises a crosslinked polymer network; more preferably, both the first component and the second component comprise a crosslinked polymer network.

Preferably, the weight ratio of the first component to the second component is from about 1:1 to 99:1; more preferably, from about 1.3:1 to 50:1; and still more preferably, from about 1.5:1 to 10:1.

Preferably, the homogeneous substantially linear ethylene/alpha-olefin copolymer having long chain branching has a density of from about 0.89 to 0.92 g/cc, more preferably, from about 0.90 to 0.92 g/cc.

Furthermore, the first component can comprise at least two long chain branched homogeneous ethylene/alpha-olefin copolymers.   Preferably, the shrink film is formed by orienting a tape in an amount of from about 2X to 12X in at least one member selected from the machine direction of the film and the transverse direction of the film; more

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preferably, from about 3X to 6X. Although the film can be formed by orienting the tape in only one direction, i.e., to form a film having monoaxial orientation, preferably the tape is oriented in both the machine direction and the transverse direction, i.e., to form a film having biaxial orientation.

Preferably, the shrink film has a thickness of from about 0.3 to 3 mils; more preferably, from about 0.6 to 0.75 mil.

The first component may further comprise a plasticizer. Preferably, the plasticizer comprises an oil, more specifically, at least one member selected from the group consisting of mineral oil, vegetable oil, animal oil, essential oil, and edible oil. Plasticizers in polymeric films can have the effect of reducing shrink tension, reducing modulus, improving optical properties (e.g., reducing haze), interfering with heat sealing, interfering with ink adhesion, and increasing the coefficient of friction (i.e., making the film tacky). These effects may be considered advantages or disadvantages, depending upon the desired film properties. Although plasticizers can be used to reduce the shrink tension in shrinkable polymeric films, the substantially linear homogeneous ethylene/alpha-olefin copolymers used in the film of the instant invention have the advantage of not requiring plasticizer to achieve low shrink tension properties.

Although the film of the present invention can be either a monolayer film or a multilayer film, preferably the film is a multilayer film. Preferably, the film has a total thickness of less than about 20 mils, more preferably the film has a total thickness of from about 0.2 to 10 mils, still more preferably from about 0.3 to 4 mils, and yet still more preferably, from about 0.4 to 2 mils.

As a second aspect, the present invention pertains to a package comprising a product packaged in the shrink film according to the present invention. The product is of a type which distorts when wrapped with a film having a shrink tension of 350 psi. A group of preferred products comprises the group consisting of paper, textile, a flower, a vinyl notebook binder, soap, and a candle. More preferably, the product comprises at least one member selected from the

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group consisting of a paper product and a textile product; still more preferably, the product comprises at least one member selected from the group consisting of a bed sheet and a pillowcase.

Preferably, the shrink film has two package comprises at least two seals thereon. These seals can be end seals and/or side seals. Preferably, the package comprises a film tube comprising the shrink film. The film tube has two ends. Each of the ends has a seal thereacross, with the film being sealed to itself across the ends of the tube.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a schematic cross-sectional view of a preferred multilayer soft shrink film according to the present invention.

Figure 2 illustrates a schematic cross-sectional view of a monolayer soft shrink film according to the present invention.

Figure 3 illustrates a schematic view of a process for producing a preferred multilayer soft shrink film in accordance with the present invention.

Figure 4 illustrates a perspective view of a packaged product according to the present invention.

Figure 5 illustrates a graphical representation of longitudinal shrink tension (i.e., shrink tension in the machine direction) as a function of temperature, for films produced according to Examples 1-5, 7, and 8, as set forth below.

Figure 6 illustrates a graphical representation of transverse shrink tension as a function of temperature, for films produced according to Examples 1-5, 7 and 8, as set forth below.

Figure 7 illustrates a graphical representation of average (L+T, i.e., machine direction plus transverse direction) shrink tension as a function of temperature, for films produced according to Examples 1-5, 7 and 8, as set forth below.

DETAILED DESCRIPTION OF THE INVENTION

As used herein, the term "film" is used in a generic sense to include plastic web, regardless of whether it is film or sheet. Preferably, films of the preset invention have a thickness of less than or equal to 0.25 millimeters.

As used herein, the term "package" refers to a product packaged in a packaging material configured partially or completely around a product.

As used herein, the phrase "shrink tension" refers to a test designed to measure the tension, or force, per unit area developed in a film specimen (the minimum x-section) during restrained shrink at temperatures within the limits of the shrink temperature range of that film, with the quantitative determination being carried out according to ASTM D 2838, as set forth in the Annual Book of ASTM Standards, Vol. 08.02, pp 384-387, which is hereby incorporated, in its entirety, by reference thereto. The phrase "average shrink tension", as used herein, refers to an average of the shrink tension values obtained for the machine direction and the transverse direction, each of these shrink tension values being determined by the ASTM method identified above.

As used herein, the phrase "free shrink" refers to the percent dimensional change in a 10 cm x 10 cm specimen of film, when shrunk at 185°F. The quantitative determination is carried out according to ASTM D 2732, as set forth in the 1990 Annual Book of ASTM Standards, Vol. 08.02, pp.368-371, which is hereby incorporated, in its entirety, by reference thereto. The phrase "average free shrink," as used herein, refers to an average of the percent free shrink values obtained for the machine direction and the transverse direction, each of these percent free shrink values being determined by the ASTM method identified above.

As used herein, the phrases "seal layer", "sealing layer", "heat seal layer", and "sealant layer", refer to an outer film layer, or layers, involved in the sealing of the film to itself, another film layer of the same or another film, and/or another article which is not a film. It should also be recognized that in the use of hot bar type sealing, up to the outer 3 mils of a film can be involved

in the sealing of the film to itself or another layer. Packages formed using a "trim seal", i.e., a seal made using a hot knife to simultaneously cut and seal the film, involves the entire structure of the film in the seal, i.e., all the layers are believed to blend together in the trim seal. With respect to packages having only fin-type seals, as opposed to lap-type seals, the phrase "sealant layer" generally refers to the inside film layer of a package, as well as supporting layers within 3 mils of the inside surface of the sealant layer, the inside layer frequently also serving as a food contact layer in the packaging of foods.

As used herein, the term "seal" refers to any seal of a first region of a film surface to a second region of a film surface, wherein the seal is formed by heating the regions to at least their respective seal initiation temperatures. The heating can be performed by any one or more of a wide variety of manners, such as using a hot wire, hot knife, heated bar, hot air, infrared radiation, ultrasonic sealing, etc. More preferably, the seal is formed by hot wire and/or hot knife. As is known to those skilled in the art, a static lap seal is another seal useful in forming a package from the film of the present invention.

A heat-shrinkable film is typically made by first being oriented at an elevated temperature (the orientation temperature) which is below the melt temperature of at least one polymer present in the film. During the orientation process, the film is generally biaxially oriented by being "stretched" in the transverse direction, and "drawn" in the machine direction. Such a process is in contrast with the manufacture of hot blown films, which are blown at a temperature above the melting point of the polymers making up the film.

In the manufacture of heat shrinkable films, preferably substantial cooling is provided at some point upstream of a first pair of nip rolls, i.e., after extrusion, cooling of the film is necessary before the film makes contact with a solid object. The type and location of the cooling means is dependent upon material properties and cooling rates. Ultimately, such processes result in a film which is heat-shrinkable in both the transverse and longitudinal directions. Upon subsequently heating unrestrained, unannealed, oriented polymer-containing material to its orientation

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temperature, heat shrinkage is produced almost to the original unstretched, i.e., pre-oriented dimensions. The orientation in oriented films can be produced in one or more of a variety of manners.

The orientation ratio of a film is the multiplication product of the extent to which the plastic film material is expanded in several directions, usually two directions perpendicular to one another. "Drawing" is orientation in the machine direction, while "stretching" is orientation in the transverse direction. For films extruded through an annular die, a tape is generally formed upon extrusion, and is thereafter cooled, repeated, and biaxially oriented by "blowing" the tape to produce a bubble and thereby form the film. Stretching, i.e., transverse orientation results from the increase in diameter obtained upon blowing the tape to form the bubble represents stretching. Drawing, i.e., machine direction orientation, is accomplished simultaneously with stretching, by running a pair of nip rolls downstream of the bubble at a higher speed than a pair of nip rolls upstream of the bubble. The simultaneously drawing tape during the bubble blowing step, with the resulting draw ratio being the surface speed of the downstream set of nip rolls divided by the surface speed of the upstream set of nip rolls. The degree of orientation is also referred to as the orientation ratio, or sometimes as the "racking ratio."

Orientation ratios are generally expressed in terms of the amount of orientation in one direction, e.g., the machine direction, times the amount of orientation in a direction perpendicular thereto, e.g., the transverse direction, e.g., "3 X 3", or "5 X 5." An orientation ratio of, for example, 3 X 3, increased the surface area by a factor of 9.

As used herein, the term "monomer" refers to a relatively simple compound, usually containing carbon and of low molecular weight, which can react to form a polymer by combining with itself or with other similar molecules or compounds.

As used herein, the term "comonomer" refers to a monomer which is copolymerized with at least one different monomer in a copolymerization reaction, the result of which is a copolymer.

As used herein, the term "polymer" refers to the product of a polymerization reaction, and is inclusive of homopolymers, copolymers, terpolymers, etc. In general, the layers of a film can consist essentially of a single polymer, or can have still additional polymers together therewith, i.e., blended therewith.

As used herein, the term "homopolymer" is used with reference to a polymer resulting from the polymerization of a single monomer, i.e., a polymer consisting essentially of a single type of repeating unit (mer).

As used herein, the term "copolymer" refers to polymers formed by the polymerization reaction of at least two different monomers. For example, the term "copolymer" includes the copolymerization reaction product of ethylene and an alpha-olefin, such as 1-hexene. However, the term "copolymer" is also inclusive of, for example, the copolymerization of a mixture of ethylene, propylene, 1-hexene, and 1-octene.

As used herein, the term "polymerization" is inclusive of homopolymerizations, copolymerizations, terpolymerizations, etc., and includes all types of copolymerizations such as random, graft, block, etc. Polymers in the films used in accordance with the present invention can be prepared in accordance with any suitable polymerization process, including solution polymerization, slurry polymerization, gas phase polymerization, and high pressure polymerization processes.

As used herein, the term "copolymerization" refers to the simultaneous polymerization of two or more monomers.

As used herein, a copolymer identified in terms of a plurality of monomers, e.g., "propylene/ethylene copolymer", refers to a copolymer in which either named monomer may copolymerize in a higher weight or molar percent than the other named monomer or monomers. However, the first-named monomer preferably polymerizes in a higher weight percent than the second listed monomer, and, for copolymers which are terpolymers, quadripolymers, etc., preferably the first-named monomer copolymerizes in a higher weight percent than the second

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monomer, and preferably the second-named monomer copolymerizes in a higher weight percent than the third monomer, etc.

As used herein, copolymers are identified, i.e, named, in terms of the monomers from which the copolymers are produced. For example, the phrase "propylene/ethylene copolymer" refers to a copolymer produced by the copolymerization of both propylene and ethylene, with or without additional comonomer(s).

As used herein, the word "mer" refers to a unit of a polymer, as derived from a monomer used in the polymerization reaction. For example, the phrase "alpha-olefin mer" refers to the residue of the monomer as present in, for example, an ethylene/alpha-olefin copolymer, the polymerization unit, or "mer", being that "residue" which is derived from the alpha-olefin monomer after it reacts to become a portion of the polymer chain, i.e., that portion of the polymer contributed by an individual alpha-olefin monomer after it reacts to become a portion of the polymer chain.

As used herein, terminology employing a "/" with respect to the chemical identity of a copolymer (e.g., "an ethylene/alpha-olefin copolymer"), identifies the comonomers which are copolymerized to produce the copolymer. As used herein, "ethylene alpha-olefin copolymer" is the equivalent of "ethylene/alpha-olefin copolymer."

As used herein, the phrase "heterogeneous polymer" refers to polymerization reaction products having a relatively wide molecular weight distribution (M_w/M_n) and a relatively wide composition distribution, e.g., LLDPE, which is prepared using conventional Ziegler-Natta catalysts. Heterogeneous polymers are useful in various layers of the film used in the present invention. There is at least one exception to the general rule that Ziegler-Natta catalysts are used to produce only heterogeneous polymers, i.e., TAFMER (TM) homogeneous linear ethylene/alpha-olefin copolymers are produced by Mitsui Petrochemical Corporation, using soluble vanadium Ziegler-Natta type catalysts. Heterogeneous polymers typically contain a

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relatively wide variety of chain lengths and a wide range of comonomer distribution both within a given polymer chain as well as between polymer chains.

As used herein, the phrase "heterogeneous catalyst" refers to insoluble catalysts which are used for the polymerization of heterogeneous polymers, as defined above. The insolubility of heterogeneous catalysts, and the irregular particle surface of such catalysts, results in a multiplicity of types of active catalytic sites, which vary in accessibility, both initially and as polymer chains grow during polymerization. Furthermore, the active catalytic sites in heterogeneous catalysts differ in Lewis acidity and steric environment. Ziegler-Natta catalysts are heterogeneous catalysts. Examples of Ziegler-Natta heterogeneous systems include metal halides activated by an organometallic co-catalyst, such as titanium chloride, optionally containing magnesium chloride, complexed to trialkyl aluminum, as is disclosed in patents such as U.S. Patent No. 4,302,565, to GOEKE, et. al., and U.S. Patent No. 4,302,566, to KAROL, et. al., both of which are hereby incorporated, in their entireties, by reference thereto.

As used herein, the phrase "homogeneous polymer" refers to polymerization reaction products of relatively narrow molecular weight distribution and relatively narrow composition distribution. Homogeneous polymers are useful in various layers of the multilayer film used in the present invention. Homogeneous polymers are structurally different from heterogeneous polymers, in that homogeneous polymers exhibit a relatively even sequencing of comonomers within a chain, a mirroring of sequence distribution in all chains, and a similarity of length of all chains, i.e., a narrower molecular weight distribution. Furthermore, homogeneous polymers are typically prepared using metallocene, or other single-site type catalysis, rather than using Ziegler Natta catalysts.

More particularly, homogeneous ethylene/alpha-olefin copolymers may be characterized by one or more methods known to those of skill in the art, such as molecular weight distribution (M_w/M_n), short chain branching distribution breadth index, and narrow melting point range and single melt point behavior. The molecular weight distribution (M_w/M_n), also known as

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polydispersity, may be determined by gel permeation chromatography. The homogeneous ethylene/alpha-olefin copolymers useful in this invention generally has (M_w/M_n) of less than 2.7; preferably from about 1.9 to 2.5; more preferably, from about 1.9 to 2.3. The short chain branching distribution breadth index of such homogeneous ethylene/alpha-olefin copolymers will generally be greater than about 70 percent. The short chain branching distribution index is defined as the weight percent of the copolymer molecules having a comonomer content within 50 percent (i.e., plus or minus 50%) of the median total molar comonomer content. The short chain branching distribution index of linear polyethylene, which does not contain a comonomer, is defined to be 100%. The short chain branching distribution index is determined via the technique of Temperature Rising Elution Fractionation (TREF). The short chain branching distribution index determination clearly distinguishes the homogeneous copolymers used in the present invention (narrow short chain branching distribution as assessed by short chain branching index values generally above 70%) from heterogeneous polymers, such as VLDPE, available commercially which generally have a broad composition distribution as assessed by short chain branching index values generally less than 55%. The short chain branching distribution index of a copolymer is readily calculated from data obtained from techniques known in the art, such as, for example, TREF as described, for example, in: Wild et. al., J. Poly. Sci. Poly. Phys. Ed., Vol. 20, p.441 (1982); L.D. Caty, "The Role of Comonomer Type and Distribution in LLDPE Product Performance", SPE Regional Technical Conference, Quaker Square Hilton, Akron, Ohio, pp. 107-119 (October 1-2, 1985); and U.S. Patent No. 4,798,081, to Hazlitt, et al. Preferably, the homogeneous ethylene/alpha-olefin copolymers have a short chain branching distribution index greater than about 70%, i.e., a short chain branching distribution index of from about 70% to 99%. Substantially linear olefin polymers which have long chain branching are "homogeneously branched", i.e., have a uniform short chain branching distribution.

In general, the homogeneous ethylene/alpha-olefin copolymers in the multilayer films of the present invention also exhibit a relatively narrow melting point range, in comparison with

"heterogeneous copolymers", i.e., polymers having a short chain branching distribution index of less than 55%. Preferably, homogeneous ethylene/alpha-olefin copolymers exhibit an essentially singular melting point, with a peak melting point (T_m), as determined by Differential Scanning Colorimetry (DSC), of from about 60°C to 105°C. Preferably the homogeneous copolymer has a DSC peak T_m of from about 80°C to 100°C.

As used herein, the phrase "essentially single melting point" corresponds to a single T_m peak at a temperature within the range of from about 55°C to 115°C, and essentially no substantial fraction of the material has a peak melting point in excess of about 115°C., as determined by DSC analysis. DSC measurements are made on a Perkin Elmer System 7 Thermal Analysis System. Melting information reported are second melting data, i.e., the sample is heated at a programmed rate of 10°C./min. to a temperature below its critical range. The sample is then reheated (2nd melting) at a programmed rate of 10°C/min. The presence of higher melting peaks is detrimental to film properties such as haze, and compromises the chances for meaningful reduction in the seal initiation temperature of the final film.

A homogeneous ethylene/alpha-olefin copolymer can, in general, be prepared by the copolymerization of ethylene and any one or more alpha-olefin. Preferably, the alpha-olefin is a C_3-C_{20} alpha-monoolefin, more preferably, a C_4-C_{12} alpha-monoolefin, still more preferably, a C_4-C_8 alpha-monoolefin. Still more preferably, the alpha-olefin comprises at least one member selected from the group consisting of butene-1, hexene-1, and octene-1, i.e., 1-butene, 1-hexene, and 1-octene, respectively. Most preferably, the alpha-olefin comprises octene-1.

However, as stated above, the homogeneous polymers required in the first component in the film of the present invention are the homogeneous substantially linear ethylene/alpha-olefin copolymers having long chain branching, as disclosed in U.S. Patent No. 5,272,236, to LAI, et. al., and U.S. Patent No. 5,278,272, to LAI, et. al., both of which (above) have been incorporated by reference thereto, in their respective entireties.

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As used herein, the phrase "homogeneous catalyst" refers to a soluble catalyst suitable for use in the polymerization of homogeneous polymers, as defined above. Some homogeneous catalysts are also referred to as "single site catalysts", due to the fact that such catalysts typically are soluble and have a single transition metal atom which is the polymerization site, which is believed to be the basis for the homogeneity of the polymers resulting from the polymerization.

As used herein, the term "polyolefin" refers to any polymerized olefin, which can be linear, branched, cyclic, aliphatic, aromatic, substituted, or unsubstituted. More specifically, included in the term polyolefin are homopolymers of olefin, copolymers of olefin, copolymers of an olefin and a non-olefinic comonomer copolymerizable with the olefin, such as vinyl monomers, modified polymers thereof, and the like. Specific examples include polyethylene homopolymer, polypropylene homopolymer, polybutene, ethylene/alpha-olefin copolymer, propylene/alpha-olefin copolymer, butene/alpha-olefin copolymer, ethylene/vinyl acetate copolymer, ethylene/ethyl acrylate copolymer, ethylene/butyl acrylate copolymer, ethylene/methyl acrylate copolymer, ethylene/acrylic acid copolymer, ethylene/methacrylic acid copolymer, modified polyolefin resin, ionomer resin, polymethylpentene, etc. Modified polyolefin resin is inclusive of modified polymer prepared by copolymerizing the homopolymer of the olefin or copolymer thereof with an unsaturated carboxylic acid, e.g., maleic acid, fumaric acid or the like, or a derivative thereof such as the anhydride, ester or metal salt or the like. It could also be obtained by incorporating into the olefin homopolymer or copolymer, an unsaturated carboxylic acid, e.g., maleic acid, fumaric acid or the like, or a derivative thereof such as the anhydride, ester or metal salt or the like.

As used herein, terms identifying polymers, such as "polyamide", "polyester", "polyurethane", etc. are inclusive of not only polymers comprising repeating units, i.e., mers, derived from monomers known to polymerize to form a polymer of the named type, but are also inclusive of comonomers, derivatives, etc. which can copolymerize with monomers known to polymerize to produce the named polymer. For example, the term "polyamide" encompasses both polymers comprising repeating units derived from monomers, such as caprolactam, which

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polymerize to form a polyamide, as well as copolymers derived from the copolymerization of caprolactam with a comonomer which when polymerized alone does not result in the formation of a polyamide. Furthermore, terms identifying polymers are also inclusive of mixtures, blends, etc. of such polymers with other polymers of a different type. More preferably, however, the polyolefin is a polymerization product of one or more unsubstituted olefins, the polyamide is the polymerization product of one or more unsubstituted amides, etc.

As used herein, the phrase "ethylene alpha-olefin copolymer", and "ethylene/alpha-olefin copolymer", is inclusive of a diverse group of polyethylene copolymers. More specifically, this phrase encompasses such heterogeneous materials as linear low density polyethylene (LLDPE), very low density polyethylene and ultra low density polyethylene (VLDPE and ULDPE); as well as linear homogeneous polymers such as those disclosed in U.S. Patent No. 3,645,992, to Elston, and metallocene-catalyzed EXACT (TM) linear homogeneous ethylene/alpha olefin copolymer resins obtainable from the Exxon Chemical Company, of Baytown, Texas, and TAFMER (TM) linear homogeneous ethylene/alpha-olefin copolymer resins obtainable from the Mitsui Petrochemical Corporation. All these materials generally include copolymers of ethylene with one or more comonomers selected from C_4 to C_{10} alpha-olefin such as butene-1 (i.e., 1-butene), hexene-1, octene-1, etc. in which the molecules of the copolymers comprise long polymer backbone chains with relatively few short chain branches. The heterogeneous ethylene/alpha-olefin commonly known as LLDPE has a density usually in the range of from about 0.91 grams per cubic centimeter to about 0.94 grams per cubic centimeter. Other ethylene/alpha-olefin copolymers include homogeneous substantially linear ethylene/alpha-olefin copolymers having long chain branching, e.g., copolymers known as AFFINITY (TM) resins, and ENGAGE (TM) resins, available from The Dow Chemical Company.

In general, ethylene/alpha-olefin copolymers comprise a copolymer resulting from the copolymerization of from about 80 to 99 weight percent ethylene and from 1 to 20 weight percent alpha-olefin. Preferably, the ethylene/alpha-olefin copolymer comprises a copolymer resulting

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from the copolymerization of from about 85 to 95 weight percent ethylene and from 5 to 15 weight percent alpha-olefin.

As used herein, the phrases "inner layer" and "internal layer" refer to any layer, of a multilayer film, having both of its principal surfaces directly adhered to another layer of the film.

As used herein, the phrase "outer layer" refers to any film layer of film having less than two of its principal surfaces directly adhered to another layer of the film. Thus, this phrase is inclusive of monolayer and multilayer films. In multilayer films, there are two outer layers, each of which has a principal surface adhered to only one other layer of the multilayer film. In monolayer films, there is only one layer, which, of course, is an outer layer in that neither of its two principal surfaces are adhered to another layer of the film.

As used herein, the phrase "inside layer" refers to the outer layer, of a multilayer film packaging a product, which is closest to the product, relative to the other layers of the multilayer film. "Inside layer" also is used with reference to the innermost layer of a plurality of concentrically arranged layers simultaneously coextruded through an annular die.

As used herein, the phrase "outside layer" refers to the outer layer, of a multilayer film packaging a product, which is furthest from the product relative to the other layers of the multilayer film. "Outside layer" also is used with reference to the outermost layer of a plurality of concentrically arranged layers simultaneously coextruded through an annular die.

As used herein, the term "adhered" is inclusive of films which are directly adhered to one another using a heat seal or other means, as well as films which are adhered to one another using an adhesive which is between the two films.

As used herein, the phrase "directly adhered", as applied to film layers, is defined as adhesion of the subject film layer to the object film layer, without a tie layer, adhesive, or other layer therebetween. In contrast, as used herein, the word "between", as applied to a film layer expressed as being between two other specified layers, includes both direct adherence of the subject layer to the two other layers it is between, as well as including a lack of direct adherence

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to either or both of the two other layers the subject layer is between (i.e., one or more additional layers can be imposed between the subject layer and one or more of the layers the subject layer is between.)

As used herein, the term "extrusion" is used with reference to the process of forming continuous shapes by forcing a molten plastic material through a die, followed by cooling or chemical hardening. Immediately prior to extrusion through the die, the relatively high-viscosity polymeric material is fed into a rotating screw of variable pitch, i.e., an extruder, which plasticates and forces the polymeric material through the die.

As used herein, the term "coextrusion" refers to the process of extruding two or more materials through a single die with two or more orifices arranged so that the extrudates merge and weld together into a laminar structure before chilling, i.e., quenching. Coextrusion can be employed in film blowing, free film extrusion, and extrusion coating processes.

As used herein, the phrase "machine direction", herein abbreviated "MD", refers to a direction "along the length" of the film, i.e., in the direction of the film as the film is formed during extrusion and/or extrusion coating.

As used herein, the phrase "transverse direction", herein abbreviated "TD", refers to a direction across the film, perpendicular to the machine direction.

As used herein, the phrase "free shrink" refers to the percent dimensional change in a 10 cm x 10 cm specimen of film, when shrunk at a specified temperature, with the quantitative determination being carried out according to ASTM D 2732, as set forth in the 1990 Annual Book of ASTM Standards, Vol. 08.02, pp.368-371, which is hereby incorporated, in its entirety, by reference thereto. The film according to the present invention preferably has an "average free shrink at 220°F", i.e., the sum of the free shrink in the machine direction, at 220°F, and the free shrink in the transverse direction, at 220°F, of less than about 65%; more preferably, from about 15 to 80 percent; still more preferably, from about 20 to 65 percent; and yet still more preferably,

from about 20 to 50 percent. Unless specified otherwise, the phrase "free shrink", as used herein, refers to total free shrink.

As stated above, in the film according to the present invention, the outer film layer(s) comprise polyolefin. Preferably, the polyolefin comprises at least one member selected from the group consisting of polyethylene and polypropylene.

To produce crosslinking, an extrudate is treated with a suitable radiation dosage of high energy electrons, preferably using an electron accelerator, with the dosage level being determined by standard dosimetry methods. Other accelerators such as a Van de Graaf generator or resonating transformer may be used. The radiation is not limited to electrons from an accelerator since any ionizing radiation may be used. The ionizing radiation can be used to crosslink the polymers in the film. Preferably, the film is irradiated at a level of from 20-150 kGy (i.e., 2-15 MR), more preferably 20-100 kGy (2-10 MR). As can be seen from the descriptions of preferred films for use in the present invention, the most preferred amount of radiation is dependent upon the film composition, thickness, etc., and its end use.

Figure 1 illustrates a cross-sectional view of a preferred three-layer soft-shrink film 10. First layer 14, which is an outer film layer and may serve as a seal layer, an abuse layer, and/or a food contact layer, comprises a polymer having a melting point somewhat higher than the melting point of a different polymer present in second layer 12, which is an inner layer comprising homogeneous substantially linear ethylene/alpha-olefin copolymer having long chain branching. Second layer 12 also serves as a bulk layer, providing the multilayer film with the majority of its strength, especially during use of film 10 as a packaging material. Third layer 16 is also an outer layer, and may also serve as a seal layer, abuse layer, and/or food contact layer.

In preferred multilayer film 10 as illustrated in Figure 1, first layer 14 and third layer 16 are of substantially identical chemical composition and substantially identical thickness, so that multilayer film 10 has a substantially symmetrical cross-section. Preferably, outer layers 14 and 16 comprise at least one member selected from the group consisting of ethylene/alpha-olefin

copolymer, polyethylene homopolymer, ethylene/vinyl acetate copolymer, polyester, and polypropylene.

Figure 2 illustrates monolayer soft-shrink film 18, an alternative to preferred multilayer film 10 illustrated in Figure 1. Monolayer film 18 of Figure 2 comprises a substantially uniform mixture of a first polymer and a second polymer. The first polymer is a homogeneous substantially linear ethylene/alpha-olefin copolymer having long chain branching; the second polymer has a higher melting point than the first polymer, and preferably comprises at least one member selected from the group consisting of ethylene/alpha-olefin copolymer, polyethylene homopolymer, ethylene/vinyl acetate copolymer, polyester, and polypropylene.

Figure 3 illustrates a preferred process for making a preferred multilayer soft-shrink film according to the present invention. Similar processes are disclosed in U.S. Patent Nos. 3,741,253, to Brax et al; 4,278,838, to Brax et al.; 4,284,458, to Schirmer; 4,532,189, to Mueller; 5,298,202 to Schirmer, all of which are hereby incorporated by reference thereto, in their respective entireties. Figure 3 illustrates a schematic of a preferred process for making the films of the present invention, e.g., the film of Figure 1, described above. As illustrated in Figure 3, individual resin components or blends which are to form each layer are fed to extruders 18 (for simplicity, only one extruder is illustrated). Inside extruder 18, the polymer beads are forwarded, melted, and degassed, following which the resulting bubble-free melt is forwarded into die head 20, and extruded through an annular die, resulting in extrudate 22, in the form of a tubing. Extrudate 22 preferably has a thickness of from about 5-50 mils. Extrudate 22 is then rapidly cooled to room temperature (optionally by water spray from cooling ring 24) and thereafter collapsed by pinch rolls 26. The quenched extrudate, i.e., solidified extrudate, now becomes known as a "tape". Although tape 22 can be irradiated, tape 22 is preferably not irradiated because polypropylene, a preferred polymer for use in the film, degrades with radiation. However, in the event that the film comprises only polymers which do not degrade upon irradiation, it may be preferred to irradiate the tape.

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Tape 22 is then heated to a preferred orientation temperature by means 28 for radiant heating (e.g., infrared radiation) and/or conductive heating (e.g., superheated steam) and/or convective heating (e.g., heated air). A preferred orientation temperature is from about 75°C to 175°C, more preferably from about 90°C to 160°C.

After reaching the desired orientation temperature, heated tape 30 is directed through pinch rolls 32, following which heated tape 30 is inflated, resulting in trapped bubble 34. Using this bubble technique, which is well known to those of skill in the art, internal air pressure stretches heated tape 30 in an amount of from about 1.5X to 8X in the transverse direction (preferably from about 3X to 7X). Simultaneously, roller speed differential, i.e., between pinch rolls 32 and 36, draws heated tape 30 in an amount of from about 1.5X to 8X in the machine direction (preferably from about 3X to 7X). In this manner, biaxially oriented film 38 is formed. Biaxially oriented film 38 is then rapidly cooled using chilled air, in order to maintain the degree of biaxial orientation. Finally, biaxially oriented film 38 is wound onto take-up roll 40.

The invention is illustrated by the following examples, which are provided for the purpose of representation, and are not to be construed as limiting the scope of the invention. Unless stated otherwise, all percentages disclosed above are based on weight.

EXAMPLE 1

A 1/4.67/1 (weight ratio) three-layer annular tape, having a wall thickness of 18.75 mils, was coextruded and thereafter quenched. The two outer layers of the annular tape were made up of a blend of two different linear low density polyethylenes. The sole inner layer of the tape was made up of a long chain branched homogeneous ethylene/alpha-olefin copolymer. More specifically, both outer layers were composed of a blend of:

(A) about 82 weight percent DOWLEX 2045.04 (TM)

ethylene/octene copolymer having a melt index (ASTM D1238, condition E) of 1 g/10min, a density of 0.920 g/cc, a peak melting point of 120°C, an octene mer content of 6.5

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weight percent (as determined by infrared analysis per ASTM D 2238 Method B), and was obtained from The Dow Chemical Company, of Midland, Michigan;

(B) about 17 weight percent DOWLEX 2035 (TM) polyethylene copolymer having a melt index of 6 g/10min, a density of 0.920 g/cc, and a peak melting point of 125°C, also obtained from The Dow Chemical Company; and

(C) approximately 1% of a blend of waxes and particulate material as an antiblock, as known to those of skill in the art of film manufacture.

The core layer was composed of 100 weight percent XU59205.01, a proprietary experimental homogeneous long chain branched ethylene/alpha-olefin copolymer having a density of 0.902 g/cc and a melt index of 1, obtained under a development agreement with The Dow Chemical Company of Midland, Michigan. The information concerning XU59205.01 and the evaluation results of the film containing the experimental polymer which are set forth in this example have been approved for release by Dow.

The coextruded and quenched tape was crosslinked by being irradiated with an electron beam to approximately 5 - 10 kilo grays ("kGy"), i.e., 0.5-1 mega rads ("MR"). The irradiation was carried out as generally described, for example in U.S. Patent Nos. 4,278,838, to Brax et al. The material was then re-heated to approximately 113°C, and oriented 500% in both the longitudinal and transverse directions, thereby producing a film having a thickness of about 0.75 mil. The free shrink and shrink tension properties of the resulting soft shrink film of this example are provided below in Table I, with Figure 5 providing a graphical illustration of the shrink tension (psi) vs. shrink tank temperature (°C).

EXAMPLE 2

A three-layer structure was produced under processing conditions substantially according to Example 1. However, the inner layer was composed of 100 weight percent ENGAGE EG8100 (TM) long chain branched ethylene/octene copolymer having a density of 0.870 g/cc, a melt index

of 1, and a melting point of 56°C, obtained from The Dow Chemical Company of Midland, Michigan. The film was formed by biaxially orienting the tape at a temperature of approximately 114°C. The free shrink and shrink tension properties of the resulting soft shrink film of this example are provided below in Table I, with Figure 5 providing a graphical illustration of the shrink tension (psi) vs. shrink tank temperature (°C).

EXAMPLE 3

A three-layer structure was produced under processing conditions substantially according to Example 1. However, the inner layer was composed of 100 weight percent AFFINITY PL1880 (TM) long chain branched homogeneous ethylene/octene copolymer having a density of 0.902 g/cc, a melt index of 1, and a melting point of 97°C, obtained from The Dow Chemical Company of Midland, Michigan. The film was formed by biaxially orienting the tape at a temperature of approximately 114°C. The free shrink and shrink tension properties of the resulting soft shrink film of this example are provided below in Table I, with Figure 5 providing a graphical illustration of the shrink tension (psi) vs. shrink tank temperature (°C).

EXAMPLE 4

A three-layer structure was produced under processing conditions substantially according to Example 1. However, the inner layer was composed of 100 weight percent AFFINITY PL1840 (TM) long chain branched homogeneous ethylene/octene copolymer having a density of 0.908 g/cc, a melt index of 1, and a melting point of 103°C, obtained from The Dow Chemical Company of Midland, Michigan. The film was formed by biaxially orienting the tape at a temperature of approximately 114°C. The free shrink and shrink tension properties of the resulting soft shrink film of this example are provided below in Table I, with Figure 5 providing a graphical illustration of the shrink tension (psi) vs. shrink tank temperature (°C).

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EXAMPLE 5

A three-layer structure was produced under processing conditions substantially according to Example 1. However, the inner layer was composed of 100 weight percent AFFINITY FM1570 (TM) long chain branched homogeneous ethylene/octene copolymer having a density of 0.915 g/cc, a melt index of 1, and a melting point of 109°C, obtained from The Dow Chemical Company of Midland, Michigan. The film was formed by biaxially orienting the tape at a temperature of approximately 114°C. The free shrink and shrink tension properties of the resulting soft shrink film of this example are provided below in Table I, with Figure 5 providing a graphical illustration of the shrink tension (psi) vs. shrink tank temperature (°C).

EXAMPLE 6

A monolayer film was produced under processing conditions otherwise substantially according to Example 1. However, the sole film layer was a blend of:

  (A) 70 weight percent AFFINITY FM 1570 (TM) substantially linear long chain branched homogeneous ethylene/octene copolymer having a density of 0.915 g/cc, a melt index of 1, and a melting point of 109°C, obtained from the Dow Chemical Company of Midland, Michigan; and

  (B) 30 weight percent DOWLEX 2045.04 (TM) linear low density polyethylene.

The tape was crosslinked by being subjected to 90 kGy electron beam irradiation, and was thereafter biaxially oriented while at a temperature of approximately 115°C, resulting in a film having a thickness of about 0.75 mil. A processing aid, polydimethylsiloxane, was applied to one side of the unoriented extrudate at a concentration of approximately 6.5 mg/ft^2.

EXAMPLE 7 (COMPARATIVE #1)

A three-layer structure was produced under processing conditions substantially according to Example 1. However, the inner layer was composed of 100 weight percent EXACT 3029

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(TM) linear homogeneous ethylene/hexene copolymer having a density of 0.910 g/cc, a melt index of 1, and a melting point of 108°C obtained from the Exxon Chemical Company of Baytown, Texas. The film was formed by biaxially orienting the tape at a temperature of approximately 116°C. The free shrink and shrink tension properties of the resulting soft shrink film of this example are provided below in Table I, with Figure 5 providing a graphical illustration of the shrink tension (psi) vs. shrink tank temperature (°C).

EXAMPLE 8 (COMPARATIVE #2)

A three-layer structure was produced under processing conditions substantially according to Example 1. However, the inner layer was composed of 100 weight percent EXACT 3032 (TM) linear homogeneous ethylene/hexene copolymer having a density of 0.900 g/cc, a melt index of 1, and a melting point of 98°C, obtained from the Exxon Chemical Company of Baytown, Texas. The film was formed by biaxially orienting the tape at a temperature of approximately 120°C. The free shrink and shrink tension properties of the resulting soft shrink film of this example are provided below in Table I, with Figure 5 providing a graphical illustration of the shrink tension (psi) vs. shrink tank temperature (°C).

A review of the graphical results in Figure 5 illustrate the fact that the above-exemplified films comprising the substantially linear homogeneous polymers, i.e., the films of Examples 1-5, provide a shrink tension substantially below the shrink tension provided by the linear homogeneous polymers of Example 7 (Comparative #1) and Example 8 (Comparative #2) at about equivalent melt index and density.

Although the present invention has been described in connection with the preferred embodiments, it is to be understood that modifications and variations may be utilized without departing from the principles and scope of the invention, as those skilled in the art will readily understand. Accordingly, such modifications may be practiced within the scope of the following claims.

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Table 1: Free Shrink (%)

Film Name	180°F			200°F			220°F			240°F			260°F		
	L	T	(L+T)/2	L	T	(L+T)/2	L	T	(L+T)/2	L	T	(L+T)/2	L	T	(L+T)/2
EXAMPLE 1	10	9	10	17	19	18	43	46	45	68	70	69	75	74	75
EXAMPLE 2	18	17	18	30	29	30	47	45	46	61	64	63	72	76	74
EXAMPLE 3	8	9	9	21	25	23	40	48	44	65	69	67	77	79	78
EXAMPLE 4	8	8	8	14	18	16	37	44	41	67	67	67	77	78	78
EXAMPLE 5	6	8	7	11	14	13	22	34	28	67	70	69	78	80	79
EXAMPLE 6	7	10	9	12	20	16	22	33	28	71	74	73	76	77	77
EXAMPLE 7	11	15	13	18	25	22	46	51	49	70	70	70	74	75	75
EXAMPLE 8	3	8	6	7	14	11	18	33	26	72	73	73	79	77	78

Table 2: Shrink Tension (psi)

Film Name	180°F			200°F			220°F			240°F			260°F		
	L	T	(L+T)/2	L	T	(L+T)/2	L	T	(L+T)/2	L	T	(L+T)/2	L	T	(L+T)/2
EXAMPLE 1	171	188	180	184	231	208	236	269	253	234	249	242	208	192	200
EXAMPLE 2	176	146	161	219	188	204	271	214	243	223	216	220	196	214	205
EXAMPLE 3	122	281	202	162	339	251	215	356	286	208	354	281	215	355	285
EXAMPLE 4	140	297	219	189	342	266	218	377	298	246	280	263	219	255	237
EXAMPLE 5	131	287	209	150	334	242	196	339	268	182	378	280	252	310	281
EXAMPLE 6	178	319	249	221	404	313	357	417	387	381	423	402	398	389	394
EXAMPLE 7	231	315	273	305	403	354	416	315	366	389	427	408	388	378	383
EXAMPLE 8	175	275	225	190	358	274	247	343	295	305	380	343	310	386	348

WHAT IS CLAIMED IS:

1. A shrink film, comprising:

(A) a first thermoplastic polymeric component comprising homogeneous substantially linear ethylene/alpha-olefin copolymer having long chain branching, the copolymer having a density of from about 0.87 to 0.92g/cc; and

(B) a second thermoplastic polymeric component having a melting point at least 10℃ higher than a melting point of the first component;

wherein the film has an average shrink tension at 220℉ of from about 50 to 300 psi.

2. The film according to claim 1, wherein the film has an average free shrink at 220℉ of at least about 15 percent.

3. The shrink film according to claim 2, wherein the shrink film has an average free shrink at 220°F of from about 15 to 80 percent, and an average shrink tension 220°F of from about 100 to 300 psi.

4. The shrink film according to claim 3, wherein the shrink film has an average free shrink at 220°F of from about 20 to 65 percent, and an average shrink tension 220°F of from about 170 to 300 psi.

5. The shrink film according to claim 4, wherein the shrink film has an average free shrink at 220°F of from about 25 to 50 percent, and an average shrink tension 220°F of from about 240 to 300 psi.

6. The shrink film according to claim 1, wherein the first thermoplastic polymeric component further comprises at least one member selected from the group consisting of ethylene/vinyl acetate copolymer, very low density polyethylene, ethylene/butyl acrylate copolymer, and ethylene/methyl acrylate copolymer.

7. The shrink film according to claim 1, wherein the second thermoplastic polymeric component comprises at least one member selected from the group consisting of ethylene/alpha-olefin copolymer, polyethylene homopolymer, ethylene/vinyl acetate copolymer, polyester, and polypropylene.

8. The shrink film according to claim 1, wherein the film is a three- layer film comprising two outer layers each comprising the second thermoplastic polymeric component, and a single inner layer comprising the first thermoplastic polymeric component, wherein the first thermoplastic polymeric component comprises a blend of about 82 weight percent of an ethylene/octene copolymer having a density of about 0.92 g/cc and a melt index of about 1 g/10min, and about 17 weight percent of an ethylene/octene copolymer having a density of about 0.92 and a melt index of about 6 g/10min.

9. The shrink film according to claim 1, wherein the shrink film is a monolayer film comprising a substantially uniform blend of the first thermoplastic polymeric component and the second thermoplastic polymeric component.

10. The shrink film according to claim 1, wherein the shrink film is a multilayer film comprising at least one inner layer comprising the first thermoplastic polymeric component, and at least one outer layer comprising the second thermoplastic polymeric component.

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11. The shrink film according to claim 10, wherein the multilayer film comprises two outer layers, and both of the outer layers comprise the second thermoplastic polymeric component.

12. The shrink film according to claim 1, wherein at least one member, selected from the group consisting of the first thermoplastic polymeric component and the second thermoplastic polymeric component, comprises a crosslinked polymer network.

13. The shrink film according to claim 12, wherein the crosslinked polymer network is formed by irradiating at a level of from about 5 to 10 kilo Grays.

14. The shrink film according to claim 1, wherein a weight ratio of the first thermoplastic polymeric component to the second thermoplastic polymeric component is from about 1:1 to 99:1.

15. The shrink film according to claim 14, wherein the weight ratio of the first thermoplastic polymeric component to the second thermoplastic polymeric component is from about 1.3:1 to 50:1.

16. The shrink film according to claim 15, wherein the weight ratio of the first thermoplastic polymeric component to the second thermoplastic polymeric component is from about 1.5:1 to 10:1.

17. The shrink film according to claim 1, wherein the homogeneous substantially linear ethylene/alpha-olefin copolymer having long chain branching has a density of from about 0.89 to 0.92 g/cc.

18. The shrink film according to claim 17, wherein the homogeneous substantially linear ethylene/alpha-olefin copolymer having long chain branching has a density of from about 0.90 to 0.92 g/cc.

19. The shrink film according to claim 1, wherein the first thermoplastic polymeric component comprises at least two homogeneous substantially linear ethylene/alpha-olefin copolymers having long chain branching.

20. The shrink film according to claim 1, wherein the film is formed by biaxially orienting a tape in an amount of from about 2X to 12X in each of a machine direction and a transverse direction, so that a biaxially oriented film is produced.

21. The shrink film according to claim 20, wherein the film is formed by biaxially orienting a tape in an amount of from about 3X to 6X each of the machine direction and the transverse direction.

22. The shrink film according to claim 1, wherein the film has a thickness of from about 0.3 to 3 mils.

23. The shrink film according to claim 22, wherein the film has a thickness of from about 0.6 to 0.75 mil.

24. A package comprising a product packaged in a shrink film, wherein the product is of a type which distorts when wrapped with a shrink film having a shrink tension of 350 psi, and the shrink film comprises:

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(A) a first thermoplastic polymeric component comprising a homogeneous substantially linear ethylene/alpha-olefin copolymer having long chain branching, the copolymer having a density of from about 0.87 to 0.92g/cc; and

(B) a second thermoplastic polymeric component having a melting point at least 10℃ higher than a melting point of the first thermoplastic polymeric component;

wherein the shrink film an average shrink tension at 220℉ of from about 50 to 300 psi.

25. The package according to claim 24, wherein the shrink film has an average free shrink at 220℉ of at least about 15 percent.

26. The package according to claim 25, wherein the product is a member selected from the group consisting of paper, textile, a flower, a vinyl notebook binder, soap, and a candle.

27. The package according to claim 26, wherein the product comprises at least one member selected from the group consisting of a paper and textile.

28. The package according to claim 27, wherein the product comprising textile comprises at least one member selected from the group consisting of a bed sheet and a pillowcase.

29. The package according to claim 25, wherein the package comprises a film tube comprising the shrink film, with the film tube having two ends, each of the ends having a seal thereacross, with the film being sealed to itself across the ends of the tube.

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Fmt
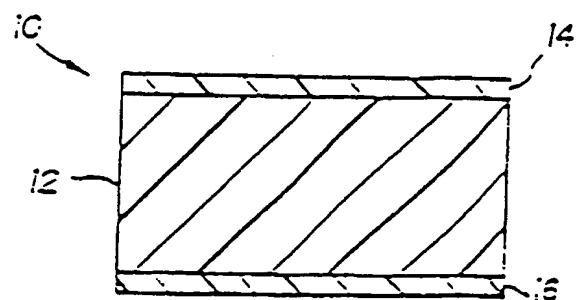
FIG 1
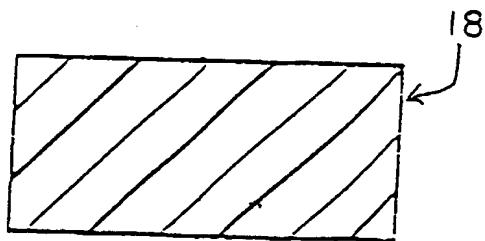
FIG 2
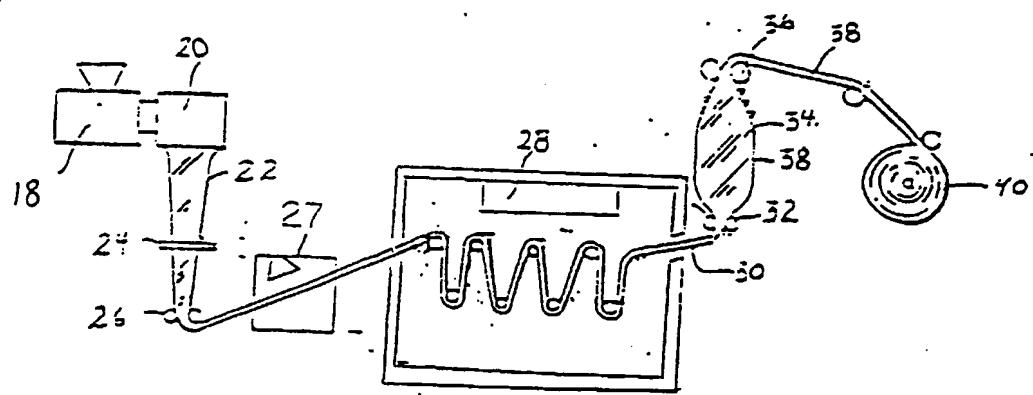
FIG 3
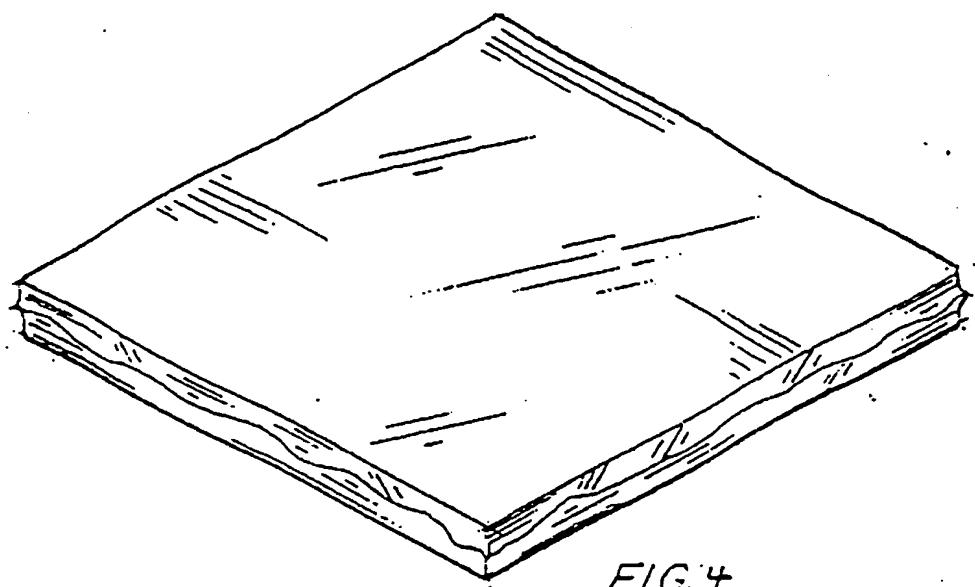
FIG. 4

Longitudinal Shrink Tension
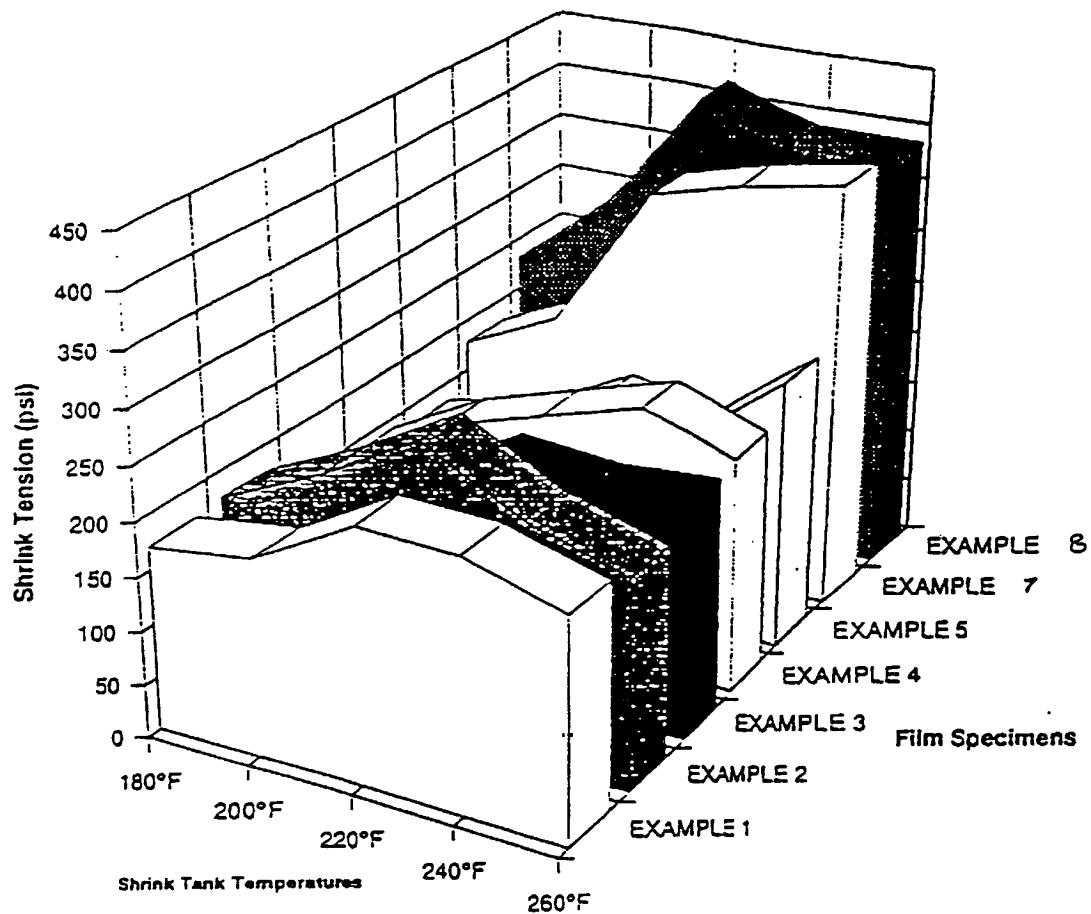
FIG 5

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Transverse Shrink Tension
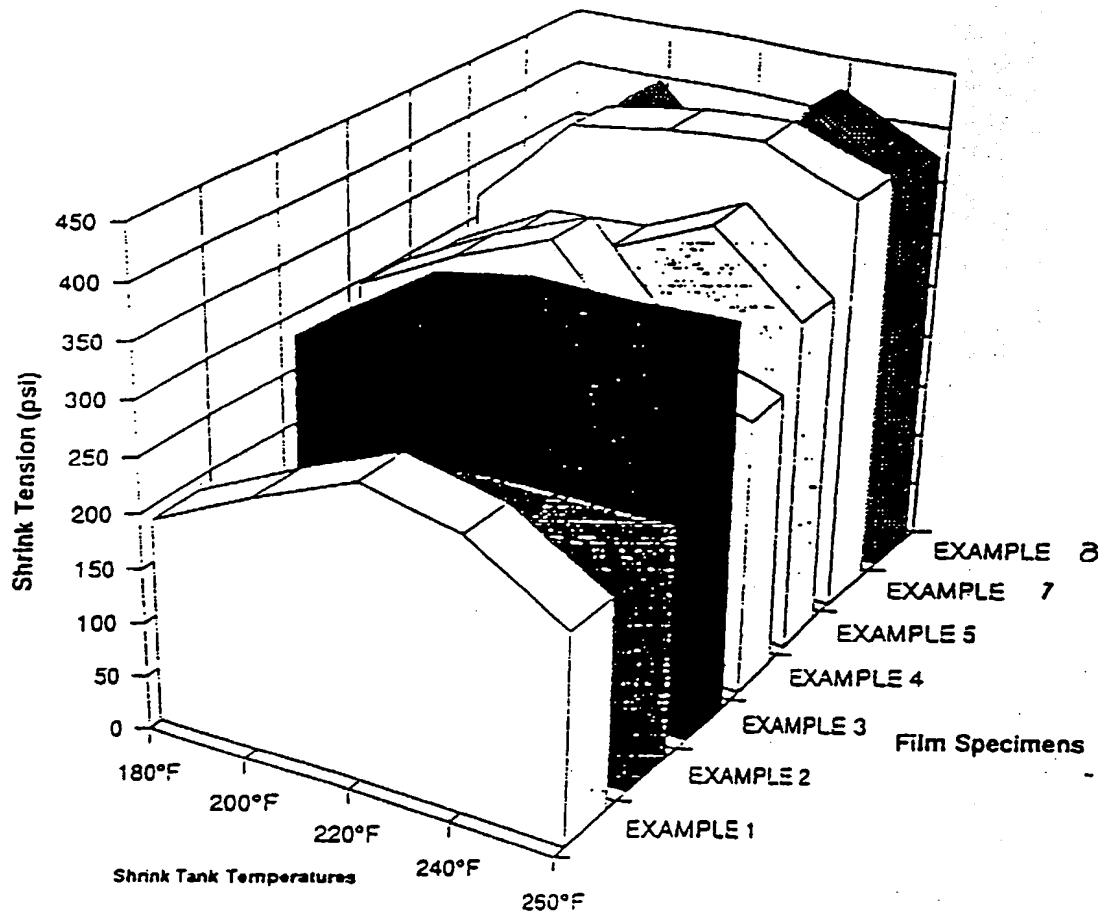
FIG 6

Average T & L Shrink Tension

FIG 7

(54) SAC A BANDE THERMORETRACTABLE, CONSTITUEE D'UN COPOLYMERE HOMOGENE D'ETHYLENE ET D'ALPHA-OLEFINE
(54) PATCH BAG COMPRISING HOMOGENEOUS ETHYLENE/ALPHA-OLEFIN COPOLYMER

(57) A patch bag has a heat-shrinkable patch adhered to a heat shrinkable bag, the heat-shrinkable patch comprising homogeneous ethylene/alpha-olefin copolymer. The patch bag can be made by adhering a patch film to a film which is thereafter converted to a bag, or by adhering the patch to a pre-formed bag. A packaged product has a meat product in the patch bag of the invention, the meat product comprising bone.
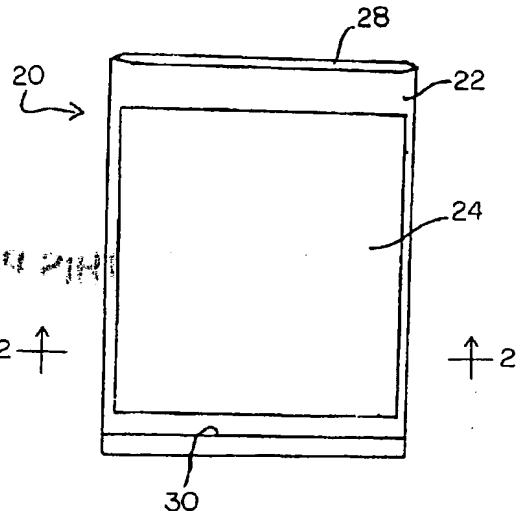
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